

CHAPTER 2

ON-SITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS

This chapter provides an overview of construction considerations and the proper function of various components of on-site sewage treatment and disposal systems. The first section summarizes various components of conventional subsurface systems. Components which are discussed include: septic tanks, distribution boxes, siphons, pumps, dosing tanks, grease traps and the types of leaching facilities allowed under Title 5, such as: leaching pits, trenches, galleries, chambers and fields.

SUGGESTED READING ASSIGNMENTS:

Title 5: Standard Requirements For The Siting, Construction, Inspection, Upgrade, and Expansion of On-Site Sewage Treatment and Disposal Systems and for the Transport and Disposal of Septage (see subparts B and C).

EPA Design Manual "Onsite Wastewater Treatment and Disposal Systems, II Office of Water Program Operations, U.S. Environmental Protection Agency, Washington, DC 20460 (see Chap. 6-8)

State of the Art Manual of Onsite Wastewater Management, National Environmental Health Association, 720 S. Colorado Blvd., Suite 990, So. Tower, Denver, CO 80222 (see Chap. 5-8)

Conventional System Components

The septic tank is usually the first in a series of components that make up the subsurface sewage disposal system (see Figure 2-1).

The **septic tank**, a watertight container of concrete or other durable material, is usually precast, but in particular circumstances may be constructed on the site. New metal tanks are not allowed. Tanks may be constructed of fiberglass or polyethylene. The most common design is a rectangular box; however, the tank may come in other configurations.

The septic tank is a pretreatment unit and its purpose is to receive raw household wastewater from the plumbing system, separate solids from the liquid portion, and discharge the clarified liquid to a soil absorption leaching facility for further treatment and disposal. When raw sewage enters the tank from the building sewer, the flow is directed downward through the septic tank tee. The heavier solids drop to the bottom of the tank where a layer of sludge forms. Lighter solids and floatable grease will float to the top of the liquid to form a scum layer.

The floating scum layer is prevented from exiting the septic tank with the reasonably clear liquid because of the outlet tee that extends below the bottom of the scum in a properly constructed and operating tank. Some decomposition of the solids occurs during the retention period that the sewage remains in the tank and the reduced material passes into the liquid where it exits the tank through the outlet tee.

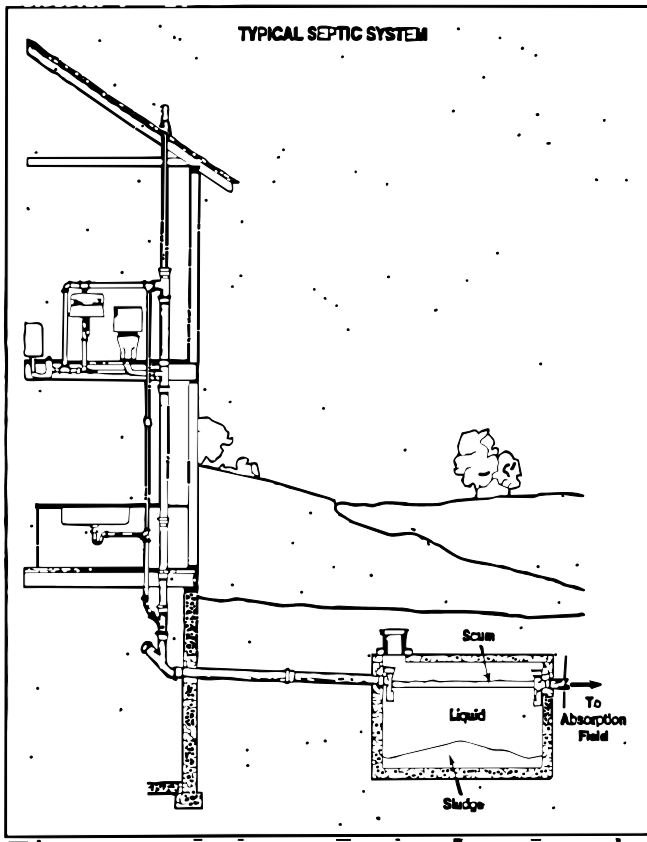


Figure 2-1: Typical Septic/On-site System

The septic tank is a vault that for single-family dwellings must have an effective liquid capacity of at least 200 percent of the design flow of sewage from the building that it serves. The minimum size tank permitted under Title 5 is 1,500 gallons. The septic tank is connected directly to the building sewer and is usually located below the surface of the ground except in extreme circumstances (as in velocity zones).

Two compartment tanks or two tanks in series are required by Title 5 when designed to serve facilities other than single family dwellings and whenever the calculated design flow is greater than 1000 gallons per day. When a domestic garbage grinder is proposed or installed, the minimum effective capacity of the septic tank must be 200% of the design flow with a minimum tank size of 1500 gallons. In addition, septic tanks receiving waste from garbage grinders must also be designed to include a two-compartment tank or two tanks in series. Garbage grinders are prohibited in systems that include elevated septic tanks.

Septic tanks must be installed level and true to grade. If placed in fill, proper compaction is required to ensure stability and minimize uneven settling. All tanks must be covered with a minimum of 9 inches of soil. At least three 20 inch diameter manholes with readily removable covers must be provided for each septic tank. Access ports must be placed at the center and over each inlet and outlet tee for inspection and cleaning. Title 5 (section 15.228 (3)) also prohibits the placement or construction of a structure on or over a septic tank where it may interfere with tank access. Please refer to section 15.228 (2) for additional detail. Figure 2-2 provides a cross sectional view of a typical septic tank.

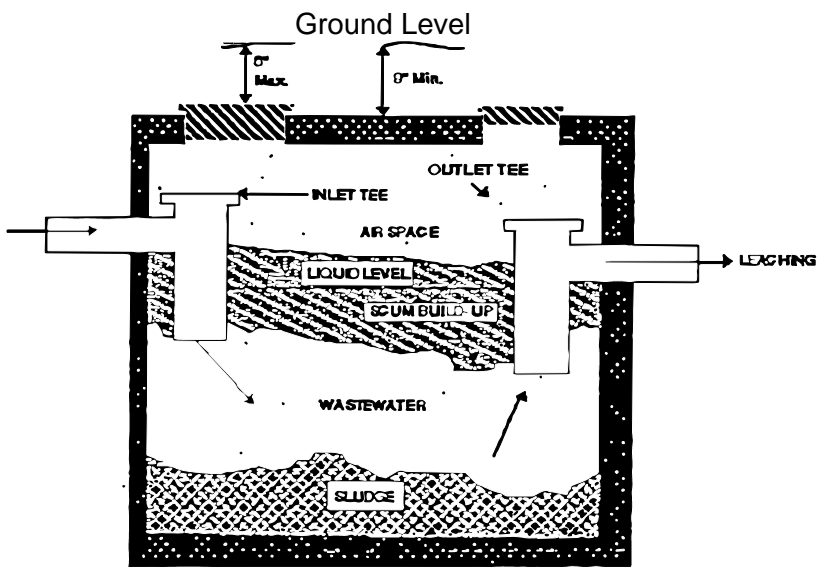


Figure 2-2: Cross Sectional View of a Typical Septic Tank

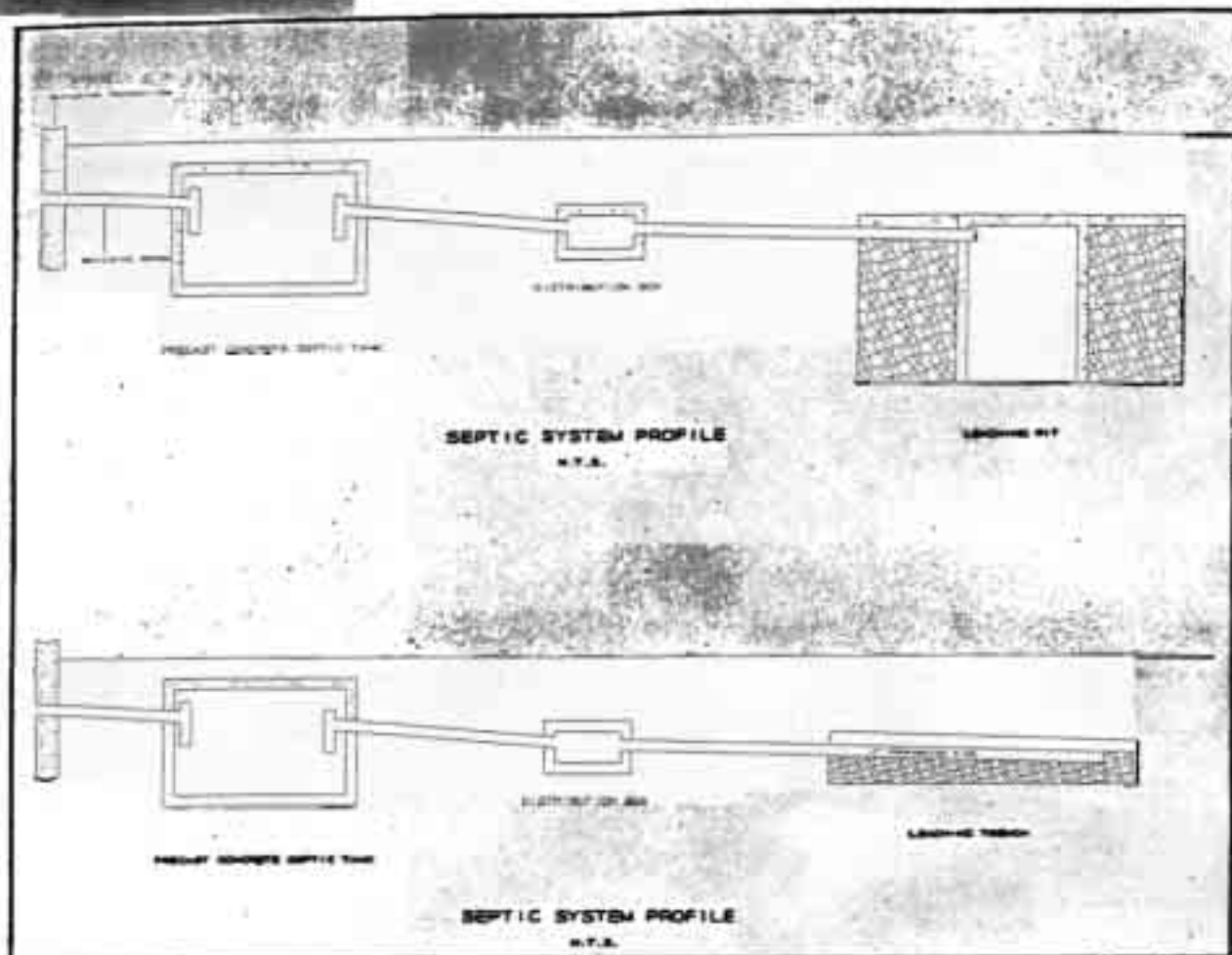


Figure 2-3: D-box Location Relative to Other Treatment Units

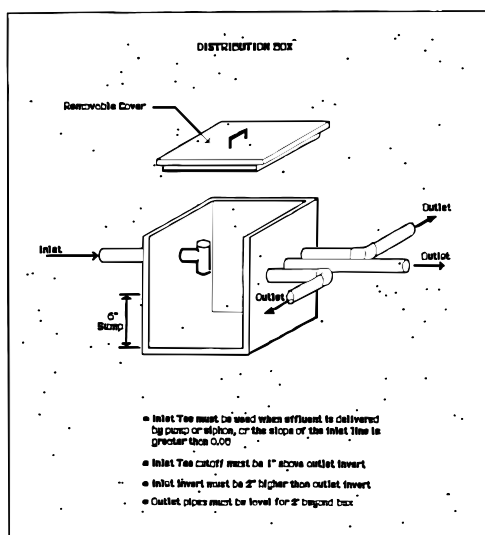


Figure 2-4 Typical D-Box Detail

A **distribution box** (d-box) is the next component in the typical subsurface sewage disposal system and is located between the septic tank outlet and the leaching facility. The distribution box, made of concrete or other durable material, must be watertight and easily accessible for inspection and cleaning. The purpose of the distribution box is to receive the flow of clarified liquid waste from the septic tank and to distribute this liquid evenly through a series of outlets discharging the wastes into the leaching facilities. Figure 2-3 shows the location of the D-box in relation to other treatment units and Figure 2-4 presents details of a typical distribution box.

As with septic tanks, d-boxes are generally constructed out of concrete but may also be constructed of plastic or other materials approved by DEP if anchored in place with or on a concrete pad which is at least 6 inches in thickness and 1.5 times the bottom surface area of the box. The d-box must have an inside minimum dimension of 12 inches with a minimum wall thickness of 2 inches. It is extremely important that the d-box be level for proper distribution of the effluent to the soil absorption system.

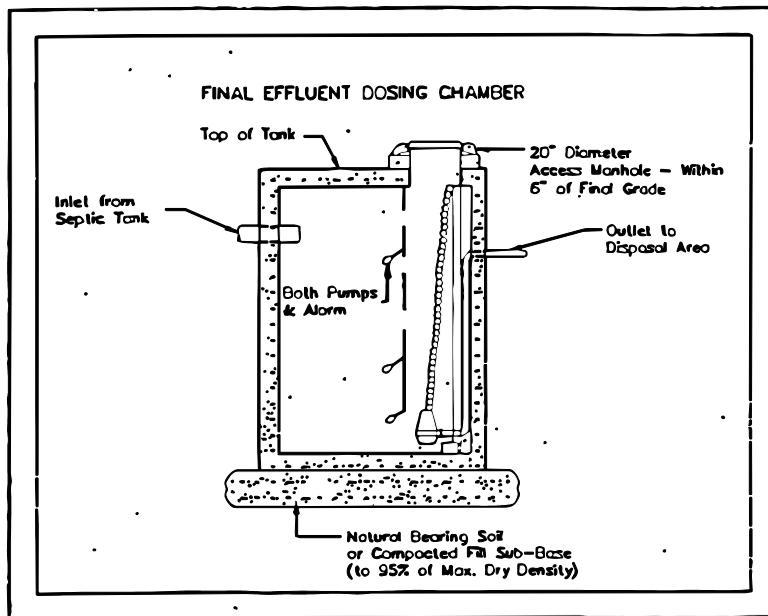


Figure 2-5 Cross Section of a Typical Dosing Chamber

Dosing tanks or chambers are used in particular situations where it is necessary to elevate wastewater for further treatment or disposal. Dosing tanks are required for any system designed for intermittent discharge of septic tank or recirculating sand filter effluent, in conjunction with pressure distribution, for any system with a design flow of greater than or equal to 2,000 gallons per day or where multiple soil absorption systems are proposed.

All dosing chambers must have an emergency storage capacity above the working level equal to the daily design flow of the system. They must also be equipped with sensors and alarms to protect against overflow due to failure of the pump or pump controls.

The dosing tank should be constructed of concrete or other approved material and vented through the building sewer or other suitable outlet. A single pump is required for each tank serving two dwelling units or less. Tanks serving more than 2 dwelling units must be equipped with two pumps with discharge lines properly valved to allow dosing of the entire absorption system by either pump. Tanks must also be equipped with at least one 20 inch manhole located within 6 inches of final grade. A cross section of a typical dosing chamber is provided in Figure 2-5.

The use of **siphons** for on-site systems, including shared systems is not allowed unless approved as a component of a recirculating--sand filter or other alternative technology. Siphons operate by building up a head of wastewater and then releasing it much like sucking water through a hose to drain a flask or barrel.

Pumps are used in a dosing tank where the dosing tank is at a lower elevation than the disposal field or the discharge point. Pumps are usually installed between the septic tank and the distribution box or leaching facility. System designs specifying pumping of sewage to a septic tank may be approved for single-family dwellings. This is acceptable where the pump discharges a volume of sewage less than 25% of the design flow of the system provided the pump discharge pipe is connected to the building sewer. For non-grinding pumps the flow rate is less than 60 gallons per minute and the septic tank has a minimum effective volume of 1,000 gallons. . For systems where grinder pumps are proposed, the discharge flow rate must be less than 20 gallons per minute and the septic tank must be at least 1500 gallons. Pumping systems designed to pump to the septic tank not meeting these minimum specifications are prohibited.

As previously stated, at least two pumps must be installed, except for systems serving two dwelling units or less. Pumps must be capable of passing a minimum solid size of 1 1/4 inch diameter and shall be installed in strict conformance with the manufacturer's specifications. Pumps must also have approved controls to ensure the correct pumping sequence:

- a. Pump off
- b. Lead pump on
- c. Backup (lag) pump on and alarm on
- d. Pumps must alternate.

All pumps must be equipped with an alarm located in the building served which is powered by a circuit separate from the circuit to the pumps. Standby power should be provided at apartment houses, condominiums, elderly housing and all other premises, which are not vacated during power failures. Pumps, alarms, and other equipment requiring periodic or routine inspection and maintenance must be maintained in strict conformance with manufacturers specifications. Inspections are required, at a minimum, once every three months for pressure distribution systems.

Grease traps are required for some subsurface sewage disposal systems, such as those of restaurants, nursing homes, hospitals, schools and other installations likely to be discharging wastes with a high content of grease. Grease traps are to be installed on a separate building sewer serving that part of the plumbing system into which the grease will be discharged. The discharge from the grease trap must flow to a properly designed septic tank or a building sewer prior to the septic tank. The purpose of a grease trap is simply to remove grease from wastewater prior to treatment. Grease traps are small flotation chambers where grease floats to the surface of the liquid and is retained while the clearer liquid below exits the tank or chamber. The grease trap design is similar to that of the septic tank (see Figures 2-6 & 2-7).

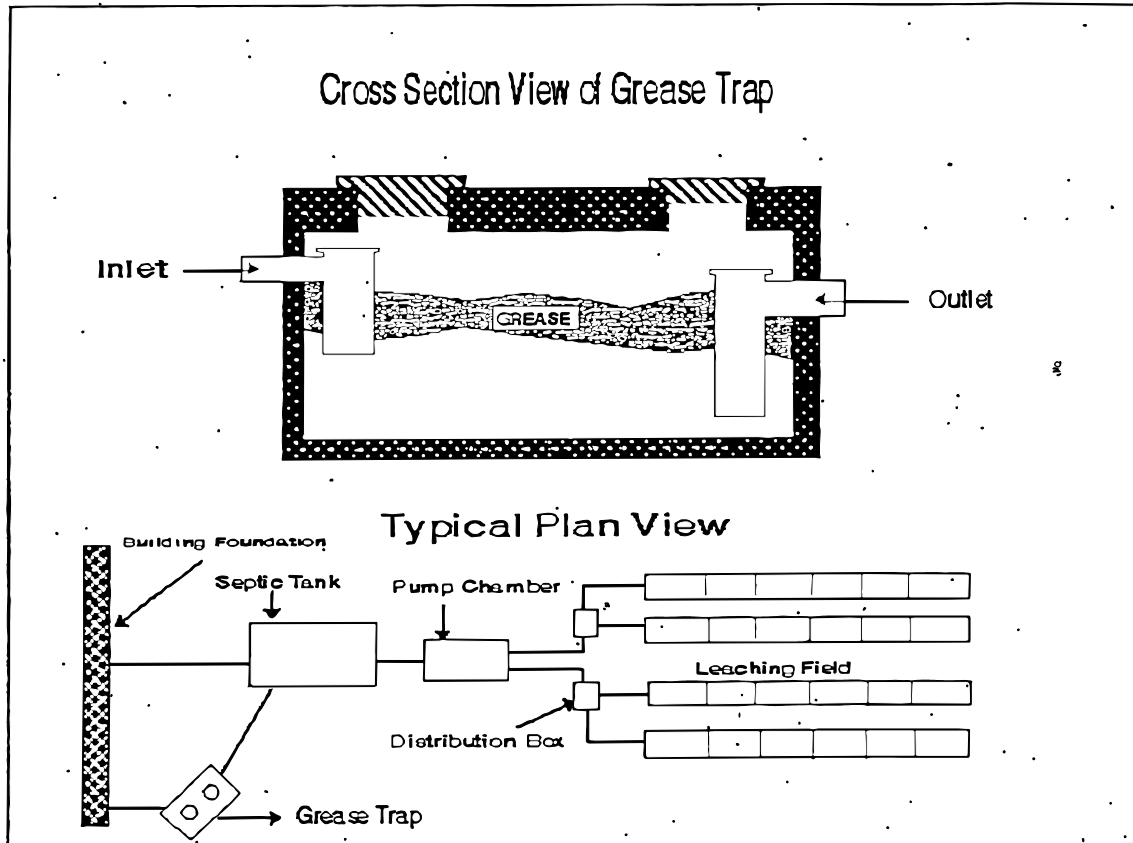


Figure 2-6

Grease traps must have a minimum depth of 4 feet and have a minimum capacity of 1000 gallons. Sufficient capacity must be provided for the kitchen flow equal to at least a 24-hour detention period. Constructed tees must be made out of cast-iron or schedule 40 PVC and properly supported by a hanger, strap, or other device. The inlet tee must extend to mid depth of the tank and the outlet tee must extend to within 12 inches of the bottom of the tank. The invert of the inlet tee must be at least two inches above the invert of the outlet tee. Access to each tee must be provided with a minimum manhole frame diameter of 20 inches.

All grease traps must be inspected monthly and must be cleaned every three months or whenever the grease is 25% of the effective depth, whichever is sooner.

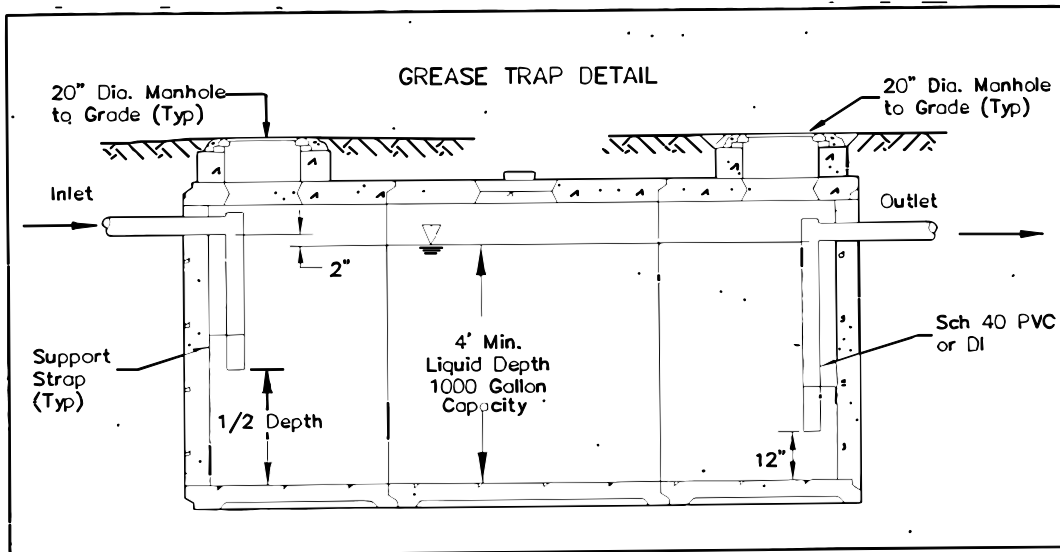


Figure 2-7

SOIL ABSORPTION SYSTEMS (SAS)

The effluent, or sewage, exiting from the septic tank has undergone primary treatment in that unit. The heavier solids have settled out at the bottom of the tank and the lighter solids, floating at the top of the liquid portion, are retained in the tank as the effluent passes under the lower opening of the outlet tee and is discharged through the outlet pipe. The partially treated sewage is carried by this watertight pipe to the leaching facility where it will undergo final treatment and disposal. The watertight pipe may carry the effluent directly into the soil absorption system (as in the leaching pit), to a distribution box (as in leaching trenches or beds), or through distribution outlets in galleries and chambers.

As the partially treated effluent enters the leaching facility, it begins to percolate through the stones placed in the soil absorption system (SAS) and then into the surrounding soil. Very shortly after the SAS is placed in use, a biological "mat" begins to form at the interface between the stones and the soil. This biological mat, or "slime area", is made up of millions of bacteria whose role is to break down the organic matter in the sewage. This mat enlarges in time as the system receives more use. The mat slows the infiltration of the liquid into the soil, thus maintaining unsaturated soil conditions below the mat. As effluent passes through the mat and then through the unsaturated soil below, pathogenic organisms and other pollutants are removed from the liquid before it reaches the groundwater. Final treatment of effluent in the subsurface sewage disposal system occurs in the SAS and its surrounding soil.

If the SAS is properly located, designed and constructed in acceptable soil, the pathogenic bacteria and fine solids will be removed from the sewage as it passes through the

leaching facility and surrounding soil. The liquid may eventually pass into the water table without a public health risk. A much lesser amount of the liquid sewage may pass into the atmosphere from the SAS and soil, by evaporation, again without a risk to public health.

There are several types of SASs that are acceptable for use under Title 5. Each type of SAS must provide a temporary retention area for the liquid sewage and a stone interface with the surrounding soil to allow for development of the biological slime layer that builds up in a functioning sewage system. The SAS must be located in pervious soil that is capable of accepting and dispersing the liquid sewage being discharged into the facility from a septic tank. In order to assure this, the new code is now requiring a soil evaluation for each system that must be conducted by soil evaluators certified by DEP.

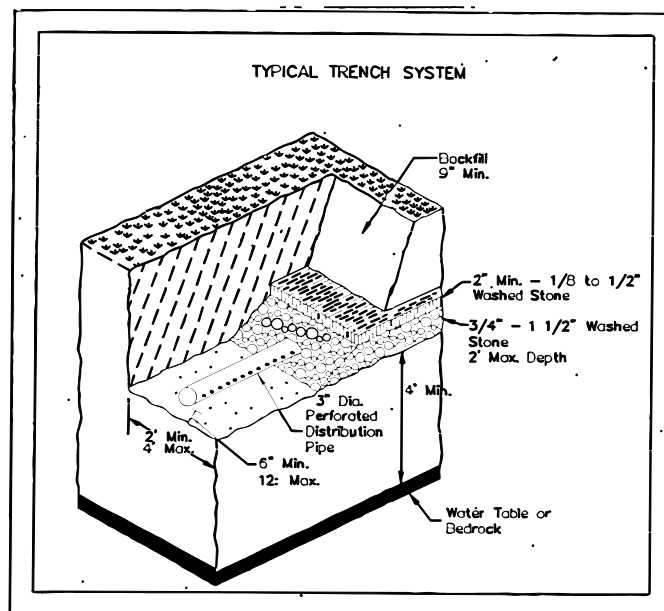


Figure 2-8

beds), differ from other designs in that they have no cavernous interior for the temporary retention of sewage while it is dispersed into the surrounding soil. The leaching trenches and fields are filled with 3/4 to 1-1/2 inch size washed stone and it is within the spaces between these stones that the sewage is retained temporarily pending absorption by the soil that surrounds the facility (see Figures 2-8 & 2-9). The leaching area used in conjunction with the long-term acceptance rate (LTAR) determined in accordance with section 15.242, shall be considered as the pervious area of the bottom of each trench and up to two feet of the sidewall of the excavation below the invert of the inlet. Impervious areas of sidewall below the inlet shall not be considered as available leaching area. However, the leaching area of the leaching field, determined under section 15.252, is limited to the pervious bottom area of the excavation only and shall not include any sidewall area.

The minimum separation distance between any two trenches must be three times the effective width or depth of each trench, whichever is greater. Trenches can have a minimum width of 2 feet and a maximum of 4 feet and must be situated, wherever possible with their long dimension (100 feet maximum length) perpendicular to the slope of the natural soil.

A reserve area sufficient to replace the capacity of the original leaching area must be provided in all installations. The area between leaching trenches may be used for part of the reserve area only where the separation distance between the excavation sidewalls of the primary trenches is at least six feet.

The use of leaching fields or beds is restricted to systems with a calculated design flow of less than 5,000 gallons per day per field. In field designs there must be a minimum of 2 distribution lines. A minimum separation distance between lines of 6.0 feet is required and a distance of 10 feet must be maintained between fields. The maximum length of each field

allowed by the code is 100 feet. Additional specifications for the design of fields or beds can be found in section 15.252.

Common to both trench and field systems are the transmission or distribution lines that convey the septic tank effluent to the absorption system. One or more d-boxes with unperforated pipes are used as conveyance pipes between the d- box and the SAS. Unperforated pipes with tight joints are also used as distribution pipes between the septic tank and the distribution box. Closed pipes are also used between trenches.

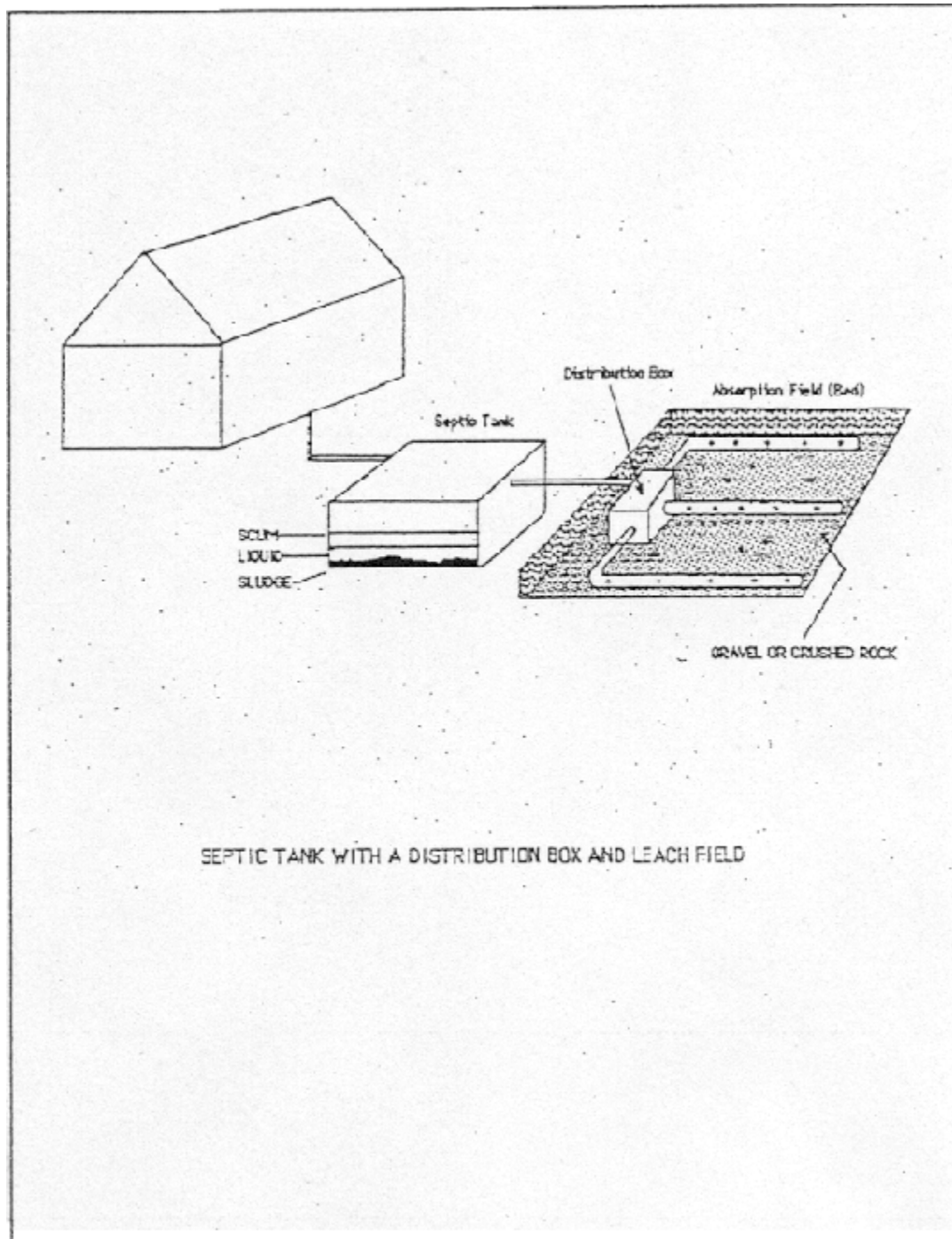


Figure 2-9

Sewage discharged from the septic tank is carried by closed pipe to a distribution box where the sewage flows into the box through an inlet. A series of outlets, all at the same elevation carry the sewage from the distribution box by closed pipes to the leaching trenches or fields. Within the leaching trench, perforated or open joint pipe is used to transport the sewage along the entire length of the trench while allowing some portion of the sewage to drain out of the perforations or open joints along the way. The sewage is thus evenly distributed among multiple trenches and over a large area of stone.

The sewage drains into the spaces between the stones where it comes into contact with the biological slime layer where biological and chemical reactions result in further treatment of the sewage. The sewage then passes into the surrounding soil where more organic and inorganic matter is removed. Some sewage is removed through capillary action and evaporation at the same time. The process in a leaching field is essentially the same, except that the distribution box is usually located within the leaching field and therefore the pipes exiting from the distribution box are not closed pipes. These are the open joint or perforated pipes that carry the sewage over the entire field. Distribution lines can be constructed of either PVC or ABS materials and must be at least 3 inches in diameter. Lines exceeding 50 feet in length must be properly vented in accordance with the provisions provided in section 15.241.

On sloping lots it is often necessary to locate leaching trenches at different elevations. This may be accomplished by using distribution boxes connected by closed pipes but must meet critical slope requirements. Sewage may be discharged into one or two trenches at an upper level from openings in a distribution box, while one or more additional openings in the same box may be used to carry sewage in a closed pipe to a second distribution box at a lower level, which in turn may service one or more additional trenches. Sewage may be disposed of in trenches on the upward slope of a septic tank in a similar manner. It would be necessary to add a pump to force the sewage exiting from the septic tank up to a distribution box at a higher elevation where it could flow by gravity to one or more leaching trenches. Where trenches are constructed at different elevations they must be designed to prevent effluent from the higher trenches from flowing into the lower trenches.

When area requirements do not permit the use of a trench system a **leaching pit** provides another alternative. A large excavation is required for the leaching pit. The lining of the pit is usually constructed in a cylindrical fashion. Pits must be constructed of precast perforated concrete or interlocking concrete blocks laid dry with open joints in a manner to prevent displacement. The cylinder may be brought to a cone at the top with a manhole, or covered with a large slab containing a manhole. The liner is surrounded on the outside with 12 to 48 inches of 3/4 to 1-1/2 inch size washed stone (see Figure 2- 10). Covering this stone is a two-inch layer of washed stone ranging from 1/8 to 1/2 inch in size. The interior of the liner, along with the spaces in between the stones surrounding it, provides storage space for the sewage while it is being dispersed into the soil at the bottom and through the open- jointed and rock filled sides.

Leaching pits may not be constructed in areas where the maximum groundwater elevation is less than four feet below the bottom of the excavation. Excavations into or fill upon impervious material are not allowed. Excavations through impervious material may be allowed if at least four feet of naturally occurring pervious material, as demonstrated by a percolation test and soil evaluation, remains beneath the lowest point of the excavation. When more than one leaching pit is installed, they must function in parallel and the distance between excavation sidewalls may be no less than twice the effective width or twice the effective depth of the pit, whichever is greater. When pits are built at different elevations, construction shall be such as to prevent sewage from upper pits from flowing into lower pits.

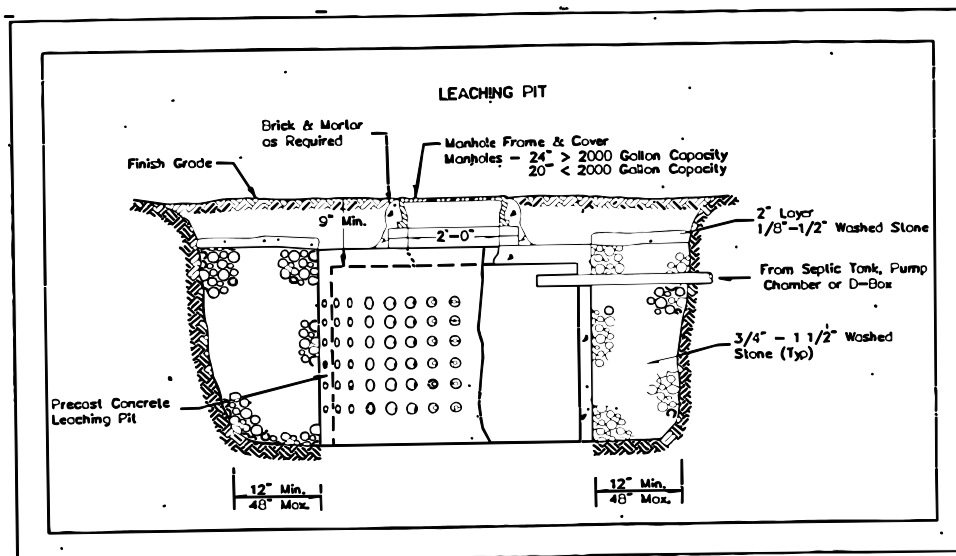


Figure 2-10

The leaching area required must be determined in accordance with the provisions of section 15.242. The leaching area shall be considered as the pervious bottom area of the excavation and a maximum of two feet of side-wall depth below the invert of the inlet per unit. Impervious area of the sidewall below the inlet may not be considered as available leaching area.

A reserve area sufficient to replace the capacity of the original leaching area must be provided in all designs and construction of subsurface sewage disposal systems. The area between leaching pits may be used for part of the reserve area.

For further specifications for leaching pits, refer to section 15.253.

Leaching galleries and **leaching chambers**, like the leaching pit, provide a large interior for visual observation to determine proper functioning, except that they are usually constructed in a rectangular or square manner and are generally shallower than the leaching pit (see Figure 2-11). Leaching galleries and chambers have open joints and are surrounded with washed stone as in the leaching pit. The sewage entering these facilities is dispersed in the interior and in the spaces between the surrounding stones, temporarily, as it is dispersed into the soil. Construction specifications for these systems are provided in section 15.253.

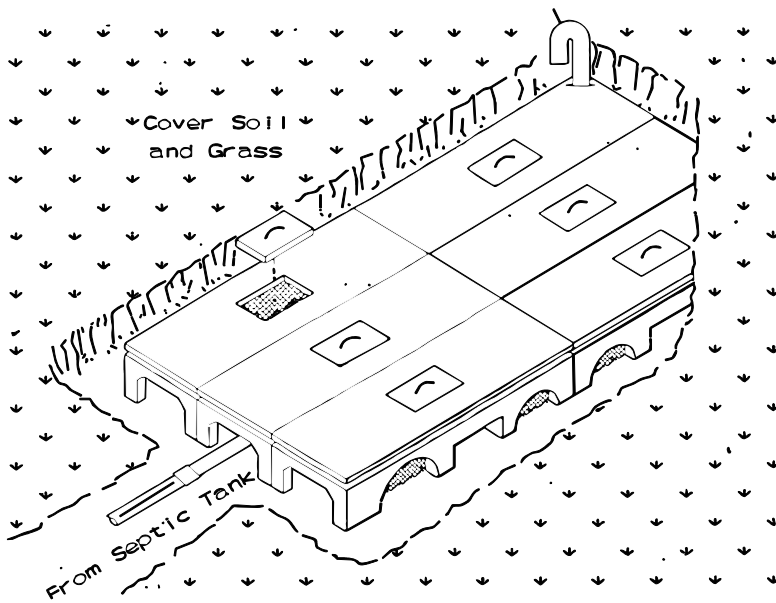


Figure 2-11

Construction in fill is allowed provided there is at least 4 feet of naturally occurring pervious material present beneath the proposed soil absorption system. Soil absorption systems constructed in fill must be sized using the 'soil type of the underlying naturally occurring pervious material. Systems constructed in fill that extend either wholly or partially above natural grade for the purpose of complying with the 4 foot separation to groundwater are considered mounded systems. It is important to note here that there are two separate 4 foot separations required by the code (i.e. depth to groundwater AND depth of naturally occurring pervious material beneath the soil absorption system) These requirements are independent of each other and as such much be evaluated independently. A typical mound system used to maintain the 4 foot separation to groundwater is presented in Figure 2-12.

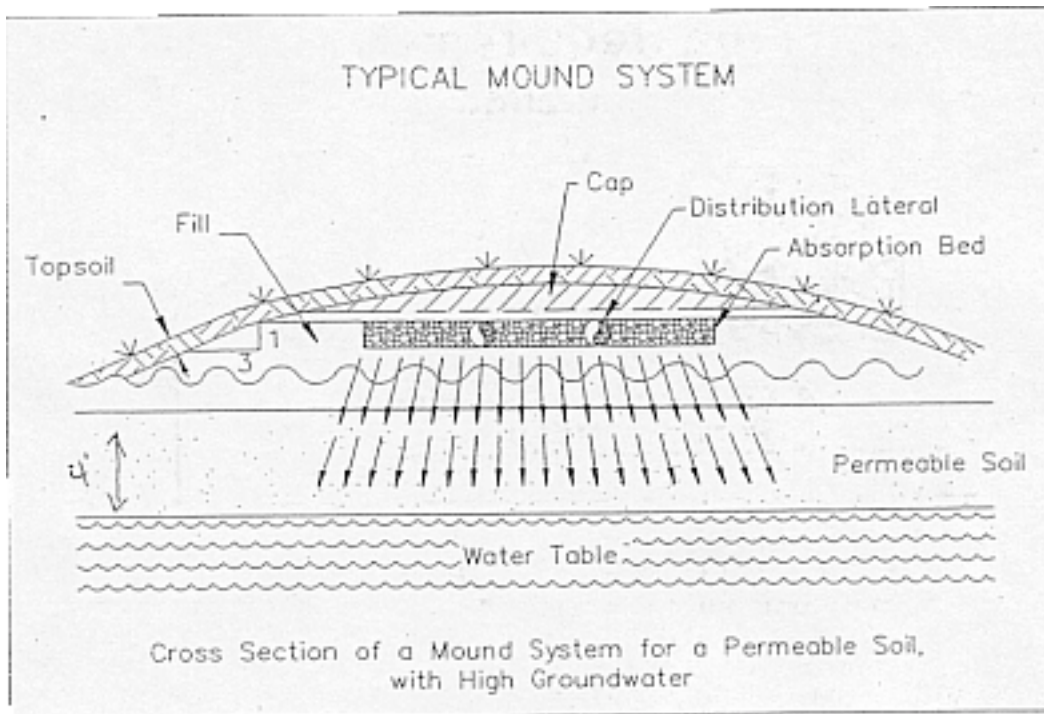


Figure 2-12

Where fill is required to replace unsuitable or impermeable soils (not including the 4 feet of naturally occurring pervious material) the excavation of the unsuitable material must extend a minimum of five feet laterally in all directions beyond the outer limit of the soil absorption system to the depth of naturally occurring pervious material. Replacement fill must meet the specifications provided in section 15.255(3). For mounded systems the side slopes cannot be steeper than 3:1 (horizontal: vertical) and a minimum horizontal separation distance of 15 feet must be provided between the soil absorption system and the adjacent side slope, as measured from the edge of the top of the two inch layer of 1/8 to 1/2 inch stone aggregate. In addition, the toe of the slope must be at least five feet from any adjacent property line or a swale or other drainage system provided to prevent runoff from migrating to the adjacent property. Adjustments to the side slope criteria may be allowed if a suitable impervious barrier, such as a vertical concrete retaining wall is provided that meets the specifications provided in section 15.255(2). Figure 2-13 illustrates the necessary slope requirements.

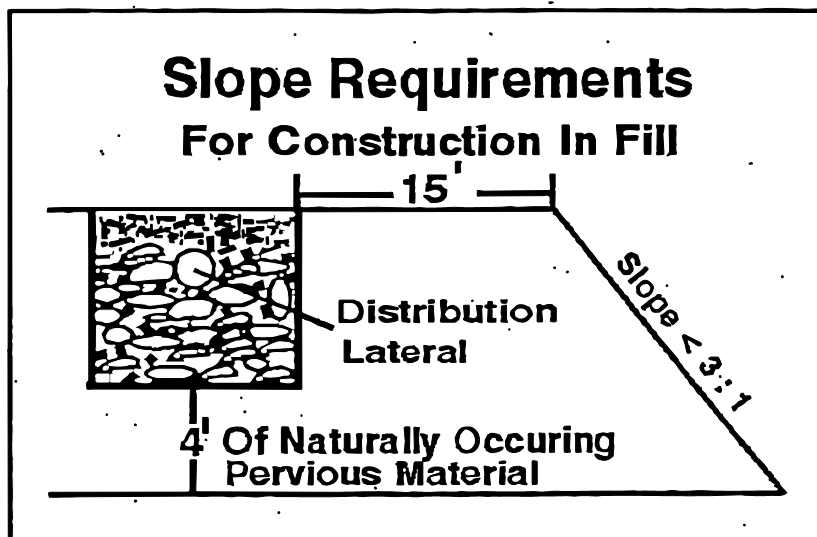


Figure 2-13: Slope Requirements for Construction in Fill

A **tight tank** is a large tank used for storage of sewage. It has an inlet but no outlet. Tight tanks cannot be approved for new construction or for increased flow to existing systems except in extreme situations that require prior Department approval. Tight tanks may be used only with DEP prior approval to eliminate a failed on-site system when no other feasible alternative to upgrade the system exists. Tight tanks approved by DEP must be sized at a minimum of 500 % (5 days storage) of the sewage system design but in no case less than 2000 gallons. Tanks also must be equipped with audio and visual alarms set to activate at 3/5 of the tank capacity. Applications to the Department must indicate the method and frequency of removal of the contents as well as the specific location and method of disposal.

The Department may also consider the use of a modified tight tank in conjunction with a soil absorption system in specific situations where the limiting factor is a percolation rate slower than 60 minutes per inch. In these cases, application for a variance must be made to the local approving authority. Additional specifications for the use of tight tanks in special areas are provided in section 15.261. Figure 3-14 provides a cross sectional view of a typical tight tank configuration.

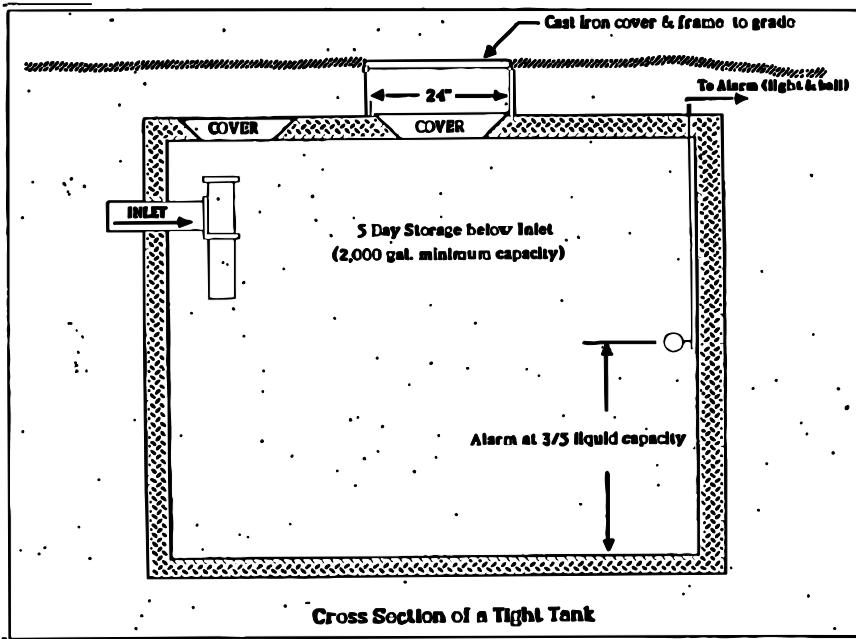


Figure 3-14